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Three hundred words were programed for presentation by teaching machine or by workbook to mentally handicapped, nonreading subjects selected from the public school system (69 subjects) and from an institution (30 subjects). Both groups were matched on chronological age, mental age, programed words known, Gray Oral Reading Test (raw score) and a paragraph reading test score. One group received instruction by teaching machine, one by programed workbook, and one by conventional classroom methods. Administration required approximately 20 hours over a 5-month period. Measures of gain and retention included programed words known, the Gray Oral Reading Test, spelling words known, and a paragraph reading test administered post-instruction and at 30- and 60-day intervals. Statistical analysis revealed both the institutional and public school groups scored significantly higher than the classroom group on the measures of programed words learned (p=.05 and .01 respectively) and on the paragraph reading test (p=.01 for both). Retention remained significantly high (p=.01) for the public school group but was not demonstrated for the institutional group. The technique was not effective for teaching spelling and in most cases scores on the Gray Oral Reading Test were not sifnificantly different among the groups. (Author/RS)

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FURTHER DEVELOPMENT, COMPARISON AND EVALUATION OF PROGRAMED INSTRUCTION FOR RETARDED CHILDREN

August 1967

U. S. DEPARTMENT OF
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FURTHER DEVELOPMENT, COMPARISON AND EVALUATION OF PROGRAMED INSTRUCTION FOR RETARDED CHILDREN

Project No. 1433
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Leslie F. Malpass
Charles F. Williams
Alden S. Gilmore

August 1967

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UNIVERSITY OF SOUTH FLORIDA

Tampa, Florida

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CHAPTER I

STATEMENT OF THE PROBLEM

This project represents the second stage of a continuing research project to develop, compare and evaluate programed instruction in reading and spelling for retarded children. The first stage, CRP 1267[1], established conclusively that retarded children can acquire and retain knowledge of common words presented under automated instructional conditions. Significant differences occurred between gain-scores of children taught under conventional classroom procedures and of those who learned by either of two types of teaching machines, in favor of the latter. However, no significant differences in acquisition or retention were observed between subjects (_S_s) taught by either method of automated instruction, _i.e_. the Wyckoff Film Tutor, an electronic typewriter-keyboard, or by the Card Master, the multiple-choice-apparatus used. The latter teaching machine method is more economical in terms of cost, both for instrumentation as well as in terms of supervisory personnel required.

This study indicated that retarded children can be taught word-recognition, simple contextual reading and spelling in a situation nearly free of human intervention. Teachers involved in CRP 1267 reported that _S_s taught by machine tended to demonstrate greater interest in classroom work than they had previously. In evaluating the process, the teachers also noted the desirability of augmenting the number of words (N=72) used in the original teaching machine programs.

It was presumed that the achievement and motivation of _S_s in the previous study were due in part to the multi-sensory presentation and feedback conditions provided by the teaching machines. However, it may be that the intrinsic nature of small-step programing is more responsible than the teaching machine itself for the improved reading and retention scores noted. If this is so, programed textbooks could serve instructional purposes as well as machines. In any event, CRP 1267 showed that two different teaching machine presentations were equally effective for helping retarded children learn to recognize words, to spell and to read in context.

Several studies have shown programed textbooks to be as effective as teaching machines with subjects of normal intelligence but programed textbooks and teaching machines have not been compared

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1. _Comparison of Two Automated Teaching Procedures for Retarded Children_; Malpass, L.F., Gilmore, A.S., Hardy, M.W., and Williams, C.F.; University of South Florida, Tampa, Florida; July 1, 1961 to July 1, 1963.

and evaluated for retarded children. (Schramm, 1962; Malpass, 1967) If programed textbooks yield results equal to teaching machine presentation, considerable financial savings would ensue to schools, to teachers and parents of retarded children, and to others interested in their education.

Widespread interest in the published results of the first study is evidenced by the fact that over 1,000 reports have been distributed by the investigators and the U. S. Office of Education. Many teachers of the retarded recommended expansion of the original program, with more emphasis on contextual presentation of words, i.e. on a more functional reading program. Toward this end, results of CRP 1267 suggest that "grade level literacy" is perhaps not so important for retarded children as literacy that will enable them to understand most ordinary written communications. It was this encouragement that prompted the investigators to continue the development of a more comprehensive program.

Related Research

The professional literature which provided the theoretical and operational bases for the first stage of the study is described in CRP 1267. It includes the contributions of Skinner, Omar Khayyam Moore, Lumsdaine and Glaser, Holland, Stolurow and others. Later studies of programed instruction for retardates have been reported by the Devereux Schools staff (1963), Naumann (1964), Blackman (1964), Ellson (1962) and Bradley (1964). Those by Naumann and Blackman are broad efforts to program total educational curricula rather than to compare specific methods or programs. Bradley's work and that of the Devereaux Schools staff are developmental projects rather than comparative evaluations.

Of special interest are results reported by Lawson and Watson (1964). They confirmed in part the efficacy of the teaching machine approach for helping retarded children learn and retain simple reading skills. These investigators found that as a group, institutionalized EMH children retained approximately 85% of the new words they had learned via teaching machines over a three-month period. This is highly congruent with results published in CRP 1267.

The utility of programed textbooks for retarded children has been investigated by Wolman and Davy (1963). The senior author developed a special reading program over several years which was then programed by Davy. They reported that both educable and trainable retardates taught with these textbooks were superior in reading achievement to those taught by conventional means. However, they did not compare the programed textbook approach with automated instruction.

Earlier studies by the investigators (1964) and others (e.g. Birnbrauer, et al, 1964; Blackman, 1964) suggest that programed instruction overcomes some of the disadvantages inherent in the typical classroom learning situation for mentally retarded children, although by no means do they indicate that PI should be used as a total substitute for classroom experience. These studies indicate that teaching machines tend to stimulate attention and interest in learning materials and contribute to a high performance in word acquisition, arithmetic, and simple reading skills.

PURPOSES OF THE STUDY

The study had two major purposes. The first was to develop a program of reading instruction composed of approximately 300 words presented in programed format adaptable both to a teaching machine and as a programed textbook. The second major objective was to compare and evaluate the effectiveness of instruction for retarded children by means of these two methods, *i.e.* teaching machine and programed textbook. It should be noted that the presentation techniques are modified somewhat from the more sterile controlled methods utilized in the original study. In CRP 1267 all efforts were made to avoid human intervention and to prevent contamination of the experimental situation by mixing tutorial instruction with automated instruction. In the present study, both because of recent research findings and because of the observations of the investigators in the previous study, some regulated human intervention was programed into the presentation modes. A corollary of the second objective was to determine the extent to which changes in spelling ability accompany changes in reading skills.

The second objective may be stated more specifically as the following null hypotheses:

(1) No significant differences in the word-recognition, phrase and paragraph reading and spelling abilities of retarded children will be observed when the same instructional program is presented by means of a teaching machine or a programed textbook.

(2) No significant differences in retention of word-recognition, reading and spelling will be observed when children taught by teaching machine and programed textbook procedures are compared 30 and 60 days after completion of instruction.

(3) No significant differences in effectiveness and efficiency of learning and retention of reading and spelling will be observed when retarded children taught by either or both of two methods of programed instruction are compared to a similar group taught only by conventional classroom procedures.

Hypothesis (1) was tested by comparing the progress of the experimental subjects on the teaching machine and programed textbook instruction over the period of time required by a subject to complete his program.

Hypothesis (2) was tested by comparing scores of subjects in each group 30 and 60 days after completion of instruction.

Hypothesis (3) was tested by comparing acquisition or retention scores of both programed instruction groups with a group exposed to conventional classroom procedures during the time required by the experimental subjects to complete the programs.

The project permitted the construction of vocabulary-reading programs sufficiently broad in scope to be of functional value to teachers and parents of retarded children. Design of the study made it possible to determine which of the two economical methods of programed instruction would be more effective in helping retarded children to read and, at least in part, to spell. Finally, by modifying the presentation techniques of the programed materials, it was possible to assess the value of structured human intervention in programed instruction.

CHAPTER II

PROCEDURE

Population Samples

Following the example of the two previous studies done by the project investigators (Malpass, et al - CRP 578 and 1267), this study included approximately 100 mentally retarded children from the public schools classes for the educable mentally retarded and from classes in an institution for the retarded. About two-thirds of the total population came from special education classes in the public schools system in Hillsborough County, and from the Special Education Center of Pinellas County. Approximately one-third of the population was drawn from the Sunland Training Center, a state institution for the retarded, located at Fort Myers, Florida.

The public school system of the State of Florida has been among the pioneers in the United States in the establishment of special classes for the educable mentally retarded. During 1966 and 1967, in nineteen of the public schools in Hillsborough County, there were twenty-six special education classes for educable mentally retarded children with IQ's ranging from 50 to 80 who were between 8 and 16 years of age. These classes are limited to enrollments of between 15 and 18 retardates each. Forty-three of the subjects for this study were drawn from eight of the twenty-six special education classes within Hillsborough County.

In Pinellas County the majority of the classes for the educable mentally retarded are located in two schools. These schools, located in the northern and southern portions of the county, enroll only educable mentally retarded children ranging in age and IQ similar to those in Hillsborough County. Twenty-six subjects for this study were drawn from the school located in the northern portion of the county, Clearwater Special Education School, Clearwater, Florida. Subjects were chosen from almost every classroom group at this age level.

Classes for the educable mentally retarded are also conducted on a regularly scheduled basis in the institutions for the retarded in the State of Florida. Subjects for this study were drawn from most of the scheduled classes at Sunland Training Center, Fort Myers.

The records of more than two-hundred-fifty possible public school subjects were examined in terms of the selection criteria; age, sex, intelligence, reading achievement and socio-economic background. Seventy of these Ss were selected from the sample available in the public schools as being relatively homogeneous with respect to the aforementioned criteria. Thirty Ss were selected from those available within the institutional setting on similar bases.

Subjects were selected for the three instructional groups in terms of the possibilities of matching them as closely as possible on the basis of the selection criteria. Then the three groups were arbitrarily assigned a title (machine, workbook, classroom). Twenty-three Ss were in each of the three groups from the public school classes and there were twelve, eleven and seven Ss respectively in the three institutional groups.

Some subject attrition occurred. In the public schools sample, one workbook subject left Florida and one machine group subject was hospitalized for an extended illness. These two Ss were not tested following instruction because they did not complete the program. At Sunland Training Center some resident students are employed outside the institution for short periods of time. Since this was the case for the majority of the classroom group and for two Ss in the workbook group, the 30-day retest was not possible with these Ss. Illness at the time of testing accounted for additional losses of Ss at testing and retesting periods.

Characteristics of the Public School Sample

Table 1 shows the matching variables for the public schools sample in terms of the selection criteria of age, mental age, word recognition and reading achievement. Mental ages utilized in this table were calculated from the Wechsler Intelligence Scale for Children or the Revised Stanford-Binet Scale.

Medical and psychological examinations administered by the public schools provided basic information on visual, orthopedic and other physical and mental attributes which may have constituted uncontrolled variables. Children with handicaps which would preclude fulfilling the mechanical requirements of the study were excluded. In cases where moderate physical handicapping conditions did exist, an attempt was made to control for them by equated assignments to the three sub-groups.

Because of the care in matching on selection criteria, and because of the difficulty in assessment of neurological damage, no attempt was made to classify the subjects according to neurological categories. It was assumed that as in most previous studies there is a relatively low frequency of serious neurological deficit among these educable subjects.

For the public schools group there were 45 male and 24 female subjects. The disparity in the number of male and female subjects in each group reflected the sex distribution within the original population.

TABLE 1

MATCHING VARIABLES

PUBLIC SCHOOLS SAMPLE

	Machine (N=23)		Workbook (N=23)		Classroom (N=23)	
	Mean	Range	Mean	Range	Mean	Range
Chronological Age	12.2	8.2-15.8	12.2	8.7-15.8	11.8	8.3-15.9
Mental Age	8.4	5.3-12.1	8.5	5.9-12.4	8.6	5.8-12.8
Programed Words Known	106.5	39-185	101.2	33-184	103.1	33-182
Gray Oral Reading (Raw Score)	6.8	0-14	5.9	0-23	7.9	0-25
Paragraph Reading	94.0	56-123	87.9	38-128	93.4	31-131

Subjects in the public school sample ranged in age from 8.2 to 15.9 years with a mean chronological age of 12.1 years. The mean chronological age for the workbook group was 12.2 years, for the teaching machine group 12.2 years, and for the classroom group 11.8 years.

The mental ages of the public school sample ranged from 5.3 years to 12.8 years with a mean mental age of 8.5 years. The mean mental age for the workbook group was 8.5 years, for the machine group 8.4 years, and for the classroom group 8.6 years. The mean MA's for the public school groups, then, are approximately the same as for normal children enrolled in typical third grade classrooms.

Reading achievement was measured in part by the Gray Oral Reading Test (Gray, W. S., 1963). The number of words recognized prior to instruction ranged from 0-23 for the workbook group, from 0-14 for the machine group, and from 0-25 for the classroom group. The mean for the workbook group was 5.9, for the machine group 6.8, and for the classroom group 7.9. These scores were calculated as the product of the number of words known, number of errors and the elapsed time, according to directions given in the Instructions for this test.

The number of programed words known was shown in previous studies (Malpass, et al, 1961 and 1963) to be an important predictor of eventual performance of experimental subjects. Thus, for this study an attempt was made to obtain sample groups which were homogeneous with respect to words known.

Pre-test recognition of programed words ranged from 33 to 185 with a mean of 103.6 words recognized by the total public schools sample. The mean word recognition scores for the three sub-groups were as follows: workbook group, 101.2; machine group, 106.5; and classroom group, 103.1.

Simple analysis of variance was run on the matching variables of mental age, programed words known at pre-testing, and the Gray Oral Reading Test raw scores. A similar procedure was followed for a paragraph reading test developed for use in this project. Results of these analyses are shown in Appendix, Table 7. Since none of the Fs obtained was significant, it is assumed that the three groups constituted a relatively homogeneous population sample.

Characteristics of the Institutional Sample

Subjects in the institutional group ranged in age from 10.2 to 19.9 years with a mean chronological age of 14.8 years. The mean CA for the teaching machine group was 14.6 years, for the programed workbook group 15.1 years; it was 14.7 years for the classroom subjects. The total institutional sample consisted of twenty males and ten females.

The mental ages for the institutional group sample ranged from 5.6 to 11.5 years with a mean MA of 8.4 years. The mean MA for the machine group was 8.0 years, for the workbook group 8.5 years, and 8.8 years for the classroom Ss.

Reading scores on the Gray Oral Reading Test ranged from 0-8 for the machine group, 0-8 for the workbook group and 0-11 for the classroom group on pre-testing. The mean for the machine group was 4.1, for the workbook group 4.3 and 4.0 for the classroom Ss.

Pre-test recognition of programed words ranged from 19 to 187 with a mean of 79.5 words recognized. The mean word recognition for the three sub-groups was as follows: machine group 78.3, workbook group 74.2 and the classroom group 89.7.

As with the public schools group, simple analysis of variance was calculated on the matching variable of mental age, programed words known on pre-testing, Gray Oral Reading Test raw scores at pre-testing and the paragraph reading test administered at pre-testing, see Appendix, Table 7. Since none of the Fs obtained was significant it is presumed that, like the public schools sample, the institutional group was relatively homogeneous in their characteristics.

Current medical and psychological assessments were available from institutional records. Because none of the Ss demonstrated any severe organic deficit, and because no particular category of medical or neurological abnormality was characteristic of any more than two subjects in any treatment group, it was not feasible to classify groups according to such criteria.

Table 2 summarizes the data given above.

Evaluation Measures

The following measures were administered prior to instruction and immediately upon completion of instruction:

1. Programed Words (number known)
2. Programed Words, Spelling (number known)
3. Gray Oral Reading Test (raw score)
4. Paragraph Reading Test (number of words read correctly in context)

Retests on most of these measures were also obtained at 30 and 60 days following completion of instruction. Full descriptions of the measures utilized are given in the succeeding sections of this chapter.

TABLE 2

MATCHING VARIABLES

SUNLAND TRAINING CENTER SAMPLE

	Machine (N=12)		Workbook (N=11)		Classroom (N=7)	
	Mean	Range	Mean	Range	Mean	Range
Chronological Age	14.6	10.4-19.9	15.1	10.2-19.3	14.7	11.6-19.7
Mental Age	8.0	5.6-10.1	8.5	5.8-11.3	8.8	7.3-11.5
Programed Words Known	78.3	39-107	74.2	38-122	89.7	19-187
Gray Oral Reading (Raw Score)	4.1	0-8	4.3	0-8	4.0	0-11
Paragraph Reading	78.3	54-114	78.8	53-119	69.0	53-115

Programed Words Known

For testing purposes the 300 programed words were typed on three sheets of paper. (Criteria for selection of words are described in the section, "Development of the Programing." Specific words are listed in Table 9 of the Appendix.) Testing for word recognition was administered individually to each subject by a research assistant. It was not possible to give instruction to every subject in precisely the same wording, but all subjects were given the same general instructions. That is, after rapport had been established, S was made to understand that the programed words did not constitute a test which might affect his school standing, but that they were used merely to determine how many words he could recognize. Subjects were told that they were not expected to know all of the words.

The research assistant sat at a desk alongside the subject and placed a word-list sheet before him on the desk, at the same time using one sheet for herself on which to mark the words correctly recognized. Scoring was done in such a manner that the S would not be discouraged by excessive failures. It was found that it was practical to give only one-half of the words to most Ss during one testing period; occasionally, three or four days were required to complete the pretesting procedures. Although some Ss showed evidence of anxiety during the testing situation, the research assistants reported unanimously that recognition of highly familiar words was not impeded. Where doubt existed concerning the validity of the testing, results were checked the the S's classroom teacher. If it was presumed that better performance should be expected, the test was readministered. The score for this assessment technique was the number of programed words correctly identified.

Spelling Words

Sixty spelling words were chosen from the programed words. Because testing for spelling was an extremely time-consuming process, it was decided to require spelling of every fifth word on the originally compiled list. (Spelling words are marked with an asterisk on Table 9 of the Appendix.) The following instructions were given to each subject: "I want to see how many of the following words you are able to spell. I will call them out and you try to spell them as well as you can." Scores were recorded by the research assistants but the Ss were not told their results. The score was the number of words correctly spelled.

Gray Oral Reading Tests

The Gray Oral Reading Test was used as a standardized measure of reading ability of the subjects. The Gray Oral Reading Test has two major functions. The first is to provide an objective measure of placement and growth in oral reading; the second is to aid in the diagnosis of oral reading difficulties. The total test battery was designed to measure skills ranging from first grade to college level. Form A and Form B were used in this study and were administered according to the standard instructions. Alternate form reliability for the GORT ranges from .973 to .982 (Gray, W. S., 1963). The first passage of both forms is introduced by a picture which provides a setting for the written context. Each passage thereafter is self-contained so that the examiner may begin with any passage without being penalized because of the omission of previous ones. Questions assessing comprehension are asked at the conclusion of each passage. The comprehension questions require only literal interpretation and repetition of details and are designed to measure understanding at the simplest level.

Paragraph Reading

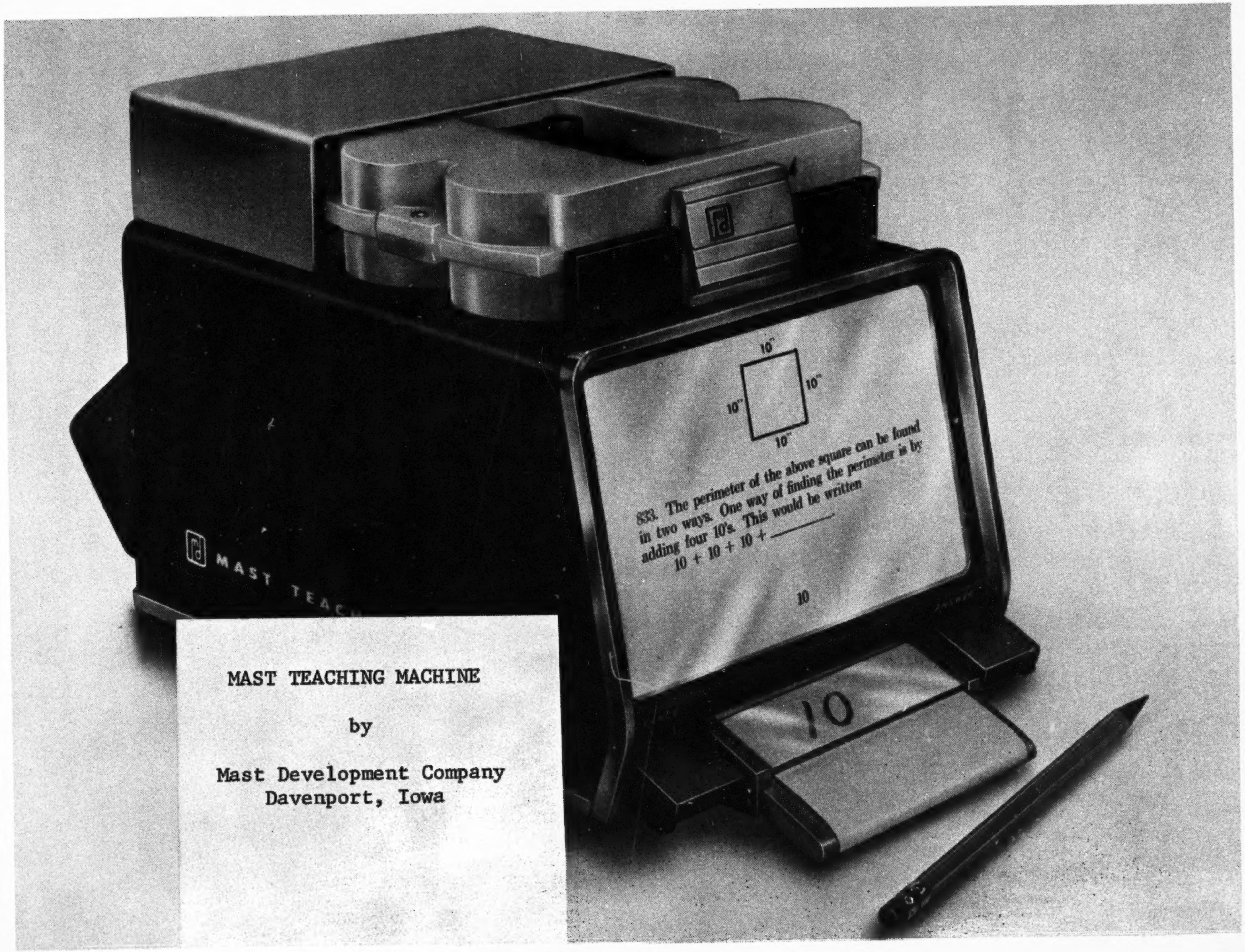
A paragraph reading test, which included 144 of the programed words used in sentence form, was designed by the experimenters. The purpose of this test was to measure the subject's ability to recognize the programed words in sequential presentation offering the cues found in normal reading situations. Administration conditions were similar to those for the word list, with the Ss reading in context. The score consisted of the number of correctly recognized words. No penalty was assessed for minor errors of inflection or for spontaneous corrections of mispronounced words.

Instructional Methods

Teaching Machine

The teaching machine groups received instruction presented mechanically by means of the Mast Teaching Machine (Mast Development Company, 2212 East 12th Street, Davenport, Iowa). This is a mechanical optical device which provides rear projection of prepared filmstrips on a ground glass screen. In operation, a student examines the exposed top three-quarters of a frame presenting an individual item in linear sequence. The S then notes his selection of response on a mechanically actuated strip of adding machine tape located directly beneath the screen. He then presses the button marked "Answer" which actuates a mechanical slide revealing the correct response and which at the same time moves the adding machine tape forward approximately one inch to a position beneath a lucite shield. The S then cannot alter his response but may still view it in relationship to the correct response. He then presses the button marked "Advance" and the upper portion of a new frame in the sequence is exposed.

Loading, set up and focus of the machine were done by the technical assistant in attendance. The mechanical operation of the machine is relatively simple and was learned rapidly by all Ss.



MAST TEACHING MACHINE

by

Mast Development Company
Davenport, Iowa

833. The perimeter of the above square can be found in two ways. One way of finding the perimeter is by adding four 10's. This would be written
10 + 10 + 10 + ________

Fig. 1. Teaching Machine

Programed Workbook

The programed workbook groups received instruction by means of linearly programed printed material prepared by a lithographic plate process from the original art work and printed materials used in making the filmstrip presentations for the Mast Teaching machines. A workbook consisted of approximately 19 pages, each page consisting of four sequential frames of programed material arranged vertically. The S, utilizing a four by six file card as a screen, first exposes the top frame on the page, which includes both the instructional material and usually a three-part multiple-choice answer. The subject indicates his choice by circling it with a pencil or by marking through it with an 'X'. He then exposes the answer portion of the frame by sliding his card approximately one-half inch further down the page and thus can compare his answer choice with the exposed correct answer. This provides the same kind of immediacy of feedback characteristic of the machine presentation.

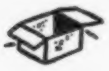
The sequence of frame presentations, the art work and all other factors are precisely the same as those utilized in the Mast Teaching Machine program. Thus, the only difference between the two presentations was that one consisted of a workbook, the other utilized a teaching machine.

Classroom

The special education classroom subjects were not exposed to the programed instructional materials *per se*. Classroom teachers of these Ss were given the list of the words to be taught via machine and workbook presentation. They agreed to attempt to integrate as many of these words as feasible into their daily classroom routine during the period of the study. In all such classes the teaching of reading and spelling was a standard part of the curriculum. Thus, the classroom routine was altered only by the introduction of a small percentage of words which might not have been taught routinely otherwise. It should be noted, however, that there is considerable overlap between the words which would ordinarily be taught in classroom sequence and words being presented in programed instruction (see Appendix, Table 9).

The investigators recognized that the classroom group cannot be considered a pure "control" group. These Ss were selected to provide base lines for enrollment over a five month period. In other words, an intent of this study was to see to what extent programed instructional materials would be effective in supplementing regular classroom instruction. Since 90% of the programed words were drawn from basic sight vocabulary lists, it was anticipated that there would be considerable overlap between the programed words and the material which was being presented in the classroom.

1-12



bed box bat

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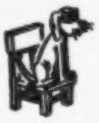
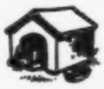
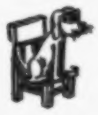
6-8



on the chair



in the house

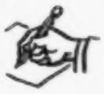


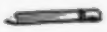
on the chair

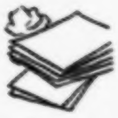
on the chair

31-48

I write on paper with a pencil.

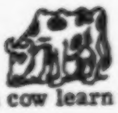






I write on paper with a pencil.

56-18



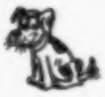
Can a cow learn to read?

Yes, a cow can learn to read.

No, a cow can't learn to read.

No, a cow can't learn to read.

56-31



A dog has ____________.

2 two legs

3 three legs

4 four legs

4
four legs

66-52

I help children learn
to read. I work in a
a school. What am I?

An entrance A teacher A policeman

A teacher

Fig. 2. Workbook - Sample Frames

Development of the Program

Word Selection

The majority of words utilized in this project (51%) were nouns. In order to make meaningful sentences and paragraphs, verbs (26%), adjectives (9%), prepositions (6%), pronouns (5%) and adverbs (3%) were also included for a total of 300 words (see Appendix, Table 9).

The words used in the program were chosen on the basis of the following criteria: ease of illustration, concreteness, polarities, structural analysis, word configuration, reinforcement of prior learning, and grammatical aspects.

The first step in word selection was an examination of the Dolch Word List, the Frye Word List, Wilson's Essential Vocabulary, and the Thorndike Word List. Words of high frequency and high interest were selected. The age range of the Ss, from ten to twenty, was the primary basis for choosing high interest, low vocabulary words, and for deleting words such as "rabbit," "kitty" and "duck." Other reasons for the choice of particular words included ease of illustration and lack of ambiguity. Verbs and adjectives which were easily paired with nouns were chosen in preference to those which were not easily paired.

In the case of adjectives, opposites were often chosen as additional words to facilitate teaching polarities (e.g. near - far, above - below). In most cases polarities were introduced in the program concurrently.

Use of the progressive and the past tense for verbs first chosen was elected in preference to introducing new verbs. This was done to enable Ss to reinforce prior learning and to take advantage of previous associations in word acquisition.

Trial subjects from the MacDonald Training Center, Tampa, Florida, were engaged in conversation using the TAT and PPVT as stimuli to ascertain that words selected for use in this project would be within the spoken vocabulary of most Ss.

Some words were included solely on the basis that they have been found extremely difficult for retardates to learn, e.g., "this" and "that." It was hoped that Ss could learn to discriminate and recognize these words. In addition, such words appear frequently in most school texts and in other material likely to be of interest to a retarded child who can read. Most words chosen had high expectancy in reading materials at the level most likely to be attempted by the Ss chosen.

An additional criterion for selection of words was their essential nature (Wilson, 1963), the likelihood that they would appear on application forms for jobs, signs, advertisements for help, or newspaper want-ad columns. Such words included "cashier," "job," "gasoline," "station," "grocery," "store," among others. Other words from the Wilson's Essential Vocabulary List, which may not be within the normal vocabulary of the retardate, _e.g._, "Beware" and "Dangerous" also were included in the program because of their possible use in aiding conceptual or connotative understanding of sentences or phrases that could be of survival value.

Another basis for including words was the format of the program itself. The basic technique used was that of structural analysis, one of the approaches most frequently used in teaching reading. This requires the reader to proceed from the simplest possible presentation or word introduction to more difficult levels. The entire sequence of word presentation utilized attempts to follow this procedure. The program begins with simple noun introduction and then proceeds to more difficult words so that sentences and phrases and paragraphs can be constructed. This simple base form, polarities, and other complexities, aid in the comprehension of the more complex sentences so that, even if the subject were unable to learn highly abstract words, he can at least make some sense from the material presented.

In essence then, an attempt was made to teach contextual reading. Use of paired verbals such as "I run," "I am running," or using past and progressive tenses facilitated the process. The introduction of inflectional endings pairing a sentence with an already known sentence also was utilized.

Question words were also used in order that the participants could respond actively to the material presented and as an aid in arousing and maintaining subject interest.

Development of the Teaching Machine Program

The investigators used their experience in the development of two other teaching machine programs supplementing it insofar as it was applicable with techniques from recent research (_e.g._, Green, 1962; Margulies, 1962; Becker, 1963; Markle, 1964). Standard programing techniques such as cueing, chaining, and fading, as well as direct practice in discrimination and recognition, were used. The basic format was that of multiple-choice items presented in linear sequence. One stimulus item and three possible response choices constituted the greater portion of the program. As phrases and sentences were developed word insertion spaces were used typically for the stimulus frame (see

Early development of the programs followed the usual techniques in the development of such programed materials. Trial series of programed frames were prepared and tested on small groups of retarded children who were not included in the final population sample. A careful record of error rate was maintained during these pre-study trials and the program underwent a series of revisions until an error rate of less than ten percent was obtained. In the early steps of validating the program, frames were made up by hand separately on four by six file cards. A research assistant sat beside the subject turning the cards for him and providing verbal feedback by answering 'right' or 'wrong' to each response. In this instance, in order to maintain task-interest, if he did not choose the correct response in the first trial, the subject was allowed alternative choices until the correct selection was made.

The program contained a high degree of repetition. After a new word was introduced, it would be presented at least twenty additional times within the next five consecutive instructional sessions. Thereafter, it was presented intermittently at a decreasing frequency throughout the remainder of the program. Early validation procedures showed the most effective rate of word recognition to be three new words per instructional session in order to maintain a favorable error rate.

Experience in the development of the program indicated that the majority of Ss grew restless if kept at the task for more than twenty minutes. It was also found that most Ss could complete 150 frames with relative ease during this period. Consequently, a daily exposure of between 100 and 200 frames was presented to each subject. Some Ss were permitted to go beyond this if their motivational level in a given day justified it.

A year of concentrated effort was required to write and adjust for error rate the program which was developed for this study. After the programing format was completed, considerable time was spent in producing the films and workbooks necessary for final presentation of the program.

In the case of the Mast Teaching Machine, typing and paste-up was performed locally on cards purchased from the Mast Development Company. These cards were forwarded to Mast Development Company for photography and the completed product was returned in an insertable plastic cassette designed for use in the automated Mast machine.

Following filming of the cards by the Mast Development Company they were returned and an additional paste-up process was required in order to obtain a format design which permitted production of photolithographic plates. Workbooks were then printed from these plates and were collated and assembled for presentation to the subjects. Each lesson sequence was printed on a different shade of pastel paper to permit rapid identification of the proper program sequence by the research assistant.

Program content, art work, and all other facets thus were the same for both of the film-actuated Mast machine and the printed workbook presentation.

Administration Conditions

During the instructional periods, each of the public schools set aside one room for the teaching machines and for tables holding the booklets. These rooms were usually classrooms or office space reserved for the project during the hours when the research was scheduled. Typically, at least three subjects were in the room simultaneously, each working at his own pace. In some cases only one S worked on a teaching machine while two others worked on workbooks although, where space was available, two and sometimes three machines were in operation simultaneously.

Completion of the program required approximately twenty hours of work, on the average. Students worked at the machines and workbooks over a period of five months from twenty to twenty-five minutes per day. They followed a regular schedule for working, coming to a special room at an appointed time each day. Upon completion of their daily lessons, they returned to their regular classrooms. It may be noted here that, although only three to five subjects were supervised by one adult in this study, it would be possible under appropriate conditions for one adult to supervise the operation of between seven to ten subjects running concurrently.

For the Mast Teaching Machines, subjects entered the room and sat at a desk or table. The research assistant would locate the proper programed sequence cassette for the subject and present the new words to be learned for the day. An effort was made to be certain that the subject understood the new words and could recognize them prior to starting the program sequence. The S then worked at his own pace choosing the correct answer and continuing to the end of the assigned program. Occasionally some of the Ss would need assistance during the lesson period from the research assistant, but most subjects were able to continue without any help whatsoever.

The same administration conditions prevailed for the workbooks. The research assistant first made certain the child could recognize the new words for that day and then encouraged him to continue on his own.

After two months of working on the program, the novelty of the programed approach dissipated somewhat for the public schools' Ss, and interest and motivation became a source of some consternation to the research assistants. At this point progress charts were constructed and verbal encouragement and praise were given freely on oral review lessons. Periodic checks also were made by asking the subject to read aloud several frames to determine his comprehension. After every five lessons, or about once a week, a brief word recognition test was programed into the sequence for encouragement and assessment of retention.

Similar administrative procedures were followed at the Sunland Training Center. The instruction room was located in the hospital building, and students would come from their residence cottages for work on a regular daily schedule. One full-time research assistant was employed to supervise all institutional subjects on both the machines and the workbooks. Three to four subjects worked on their lessons at any given time.

Statistical Treatment

In creating the instructional groups, the matching variables were considered in the following order of importance: words known on pre-testing from the three hundred programed words, mental age, chronological age, scores on the paragraph reading test made up of the programed words, scores on the Gray Oral Reading Test and sex. After the groups were composed, they were assigned as to particular instructional methods groups, _i_. _e_., programed workbook, teaching machine and classroom group respectively. Pre and post-test measures are discussed earlier in this section. Gain scores are considered to be the difference between the pre-test and post-test scores on the variables noted. Retention was measured directly in terms of the increment or decrement of the post-instruction scores at 30 and 60-day levels.

Homogeneity of the groups was determined by means of _F_-tests. Significance of the differences among the various variable scores was also identified by means of _F_-tests and, when significant, subsequently by the use of _t_-tests.

CHAPTER III

RESULTS

The study had two major objectives. The first was to develop a program of reading instruction composed of approximately 300 words presented in program format adaptable to a teaching machine and for use as a programed textbook. The second major objective was to compare and evaluate the effectiveness of instruction for retarded children by means of these two methods of programed presentation. The program developed was presented under experimental conditions to groups of public school and institutional subjects with results compared among matched groups of subjects designated as teaching machine, programed workbook, and classroom.

Hypothesis (1) states that no significant differences in reading and spelling ability of retarded children will be observed when the same instructional program is presented by means of a teaching machine or a programed textbook.

Hypothesis (2) states that no significant differences in retention will be observed when children taught under automated and programed textbook procedures are compared 30 and 60 days after completion of instruction.

Hypothesis (3) states that no significant differences in efficiency and retention of reading and spelling will be observed when retarded children taught by programed instruction are compared to a similar group exposed only to conventional classroom procedures.

The primary measures chosen to determine the efficacy of the two experimental procedures for teaching reading and spelling were: (1) the gains in the abilities to recognize (read) the programed words and to spell the programed words over the pre-test and post-test instructional period and (2) the ability to recognize these words at 30-day and 60-day intervals after instruction had been terminated. In addition to the specific measures of gains in word recognition and spelling among the programed words, pre and post-testing was also done with the Gray Oral Reading Test. The Gray Oral Reading Test is normally reported in grade equivalencies, but the raw scores for this test will be reported unless otherwise indicated. The decision to use raw scores was based upon the greater performance differentiation permitted by the raw scores and upon the greater ease in statistical computation.

An additional measure, a paragraph reading test, constructed of 144 of the 300 programed words, was administered on the same basis as the Gray Oral Reading Test in order to further appraise contextual reading skills.

Results of evaluations with the above named measures are presented in terms of the two major population samples studied, the public schools group and the institutional group.

THE PUBLIC SCHOOLS GROUP

Table 3 provides a summary of performance of the programed instruction and classroom groups in terms of gains over the pre-test and post-test periods, gains over the pre-test to 30-day retesting and gains over the pre-test to 60-day retesting. The data shown in this table represent the major findings of the study for this group.

Among the public schools subjects the mean pre-test to post-test word gain for the teaching machine method was 103.7 words. For the workbook group the mean gain was 109.0 words. The gains for these groups are more than 100 percent greater than the gain of 46.3 words for the classroom group. These gains also represent slightly greater than 100 percent improvement in terms of gains over the number of words known prior to instruction.

The mean gains of programed instruction subjects were achieved in an average of eighteen hours of instructional time. Subjects within plus or minus one standard deviation of eighteen hours ranged in instructional time from fourteen to twenty-one hours. Thus most subjects taught by means of either teaching machine or programed workbook gained more than five words per hour of instruction, compared to mean gains of 2.5 words per hour of instruction for subjects taught by conventional EMH classroom procedures.

Testing done 30 days following completion of instruction revealed mean gains of 87.9 words for the machine group, 97.2 words for the workbook group and 44.9 words for the classroom group. At the end of 60 days the mean word gains for the machine group were 100.4 for the workbook group 92.7, and for the classroom group 48.7. These gains represent a measure of retention of acquired words at 30 and 60-day intervals. Again, there were significant differences in favor of both programed instruction groups over the subjects taught by conventional EMH classroom procedures. These findings represent one of the most telling results of the study, since very few studies of retarded children have demonstrated such high retention levels in learning verbal skills. Expressed as percentages the retention rate is 84.8% of the words learned during instruction for the machine group and 89.1% for the programed workbook group. The scores shown at 60-day post-testing which reflect increases over the 30-day scores for the machine and classroom groups may reflect in part the continued exposure of the subjects to the words both under experimental conditions and in regular classroom work.

Mean gains in spelling over the pre-instruction to the post-instruction period were 5.7 words for the machine group, 5.6 words for

TABLE 3

MEAN WORD GAINS FOLLOWING INSTRUCTIONS

PUBLIC SCHOOLS SAMPLE

	Machine	Workbook	Classroom
Programed Words (Words=300)			
Pre-Test to Post-Test	103.7	100.9	46.3
Pre-Test to 30 Day Retest	87.9	97.2	44.9
Pre-Test to 60 Day Retest	100.4	92.7	48.7
Programed Spelling Words (Words=60)			
Pre-Test to Post-Test	5.7	5.6	3.4
Pre-Test to 30 Day Retest	6.0	5.6	4.9
Pre-Test to 60 Day Retest	6.0	5.9	5.8
Gray Oral Reading Test (Raw Score)			
Pre-Test to Post-Test	0.8	1.1	2.2
Paragraph Reading Test (Words=144)			
Pre-Test to Post-Test	29.3	28.7	8.9
Pre-Test to 30 Day Retest	25.8	23.5	10.9
Pre-Test to 60 Day Retest	32.2	26.0	13.5

the workbook group and 3.4 words for the classroom group. These gains remained relatively consistent at the 30 and 60-day testing levels for the machine and workbook group. At the 30-day retest the machine group recognized 6.0 words, the workbook group 5.6 words and the classroom group 4.9 words. On the 60-day retest word-gain scores from the machine group remained at 6.0 while for the workbook group they had increased to 5.9. Gains in the classroom group rose to 5.8, a score which may be the function of progress in the on-going classroom teaching situation.

Scores on the Gray Oral Reading Test, which reflects relatively few of the words actually being taught via the programed sequences, indicated greater gains over the instructional period for the classroom group than for the machine and workbook groups. The mean gain for the classroom group was 2.2 words, in contrast to .08 mean words for the machine group and 1.1 mean words for the workbook group. Testing with the Gray Oral Reading Test was not done at 30 and 60-day intervals for reasons noted in the preceding chapter.

On the paragraph reading test constructed by the authors, mean word gains over the instructional period were 29.3 for the machine group, 28.7 for the workbook group, and 8.9 for the classroom group. On 30-day retesting the machine group mean had fallen to 25.8 words, the workbook group had fallen to 23.5 words and the classroom group mean word score had gained, rising to 10.9 words. At the sixty-day interval, increased scores for the machine group can be attributed either to reminiscence or to on-going classroom instruction. The machine group showed a score of 32.2 words as opposed to 26.0 words for the workbook group, and 13.5 for the classroom group. For the specific words included in the program, both sight recognition and the programed words as utilized in the paragraph reading test, the Ss taught by both programed instruction methods gained and retained significantly more than did Ss in the EMH classroom groups. Differences on gains on a paragraph reading test were not significant between groups and were not as dramatic as for the programed words.

Statistical Analysis of the Scores

Simple analysis of variance was run among all gain scores. The F ratios are summarized in Appendix, Table 21.

For the entire public schools group, simple analysis of variance showed that the gains in word recognition were significant at the .01 level for the pre-test to post-test, for the pre-test to the 30-day retest, and for the pre-test to 60-day retest.

A t-test was employed to evaluate differences between the three pairs of treatment groups over the pre to post-test periods. A summary of all t-ratios is given in Appendix, Table 23.

Mean performance scores of Ss taught by the machine method and by the workbook method differed significantly from the mean performance scores of the classroom method at the .01 level of confidence for the pre-test to post-test period, for the pre-test to 30-day retest period and for the pre-test to 60-day retest period. In each case the difference favored the programed instruction group over the classroom group.

Simple analysis of variance was also run on the scores representing gains in spelling from pre-test to post-test, from pre-test to 30-day retest and from pre-test to 60-day retest. The F ratios are summarized in Appendix, Table 21.

While mean gains scores favored both the machine and the workbook group over the classroom group, the F ratios were not significant at the .05 level for the pre to post-test period, the pre-test to 30-day retest period, and for the pre-test to 60-day retest period. Consequently t-ratios were not calculated for these data.

Analysis of variance also was run on the raw scores for the Gray Oral Reading Test over the pre-test to post-test instructional period. Since none of the F ratios obtained was significant at the .05 level, t-ratios were not calculated.

Analysis of variance computed for raw scores of the paragraph reading test over the pre-test to post-test period, over the pre-test to 30-day retest period, and over the pre-test to 60-day retest period revealed all three sets of gains scores to be significant at the .01 level. These data are presented in Appendix, Table 21.

The t-test run between each set of groups over each of the three test periods revealed no significant differences between the machine and the workbook groups. Over the pre-test to post-test instructional period, however, differences were significant between both the workbook and classroom groups and the machine and classroom groups. Over the pre-test to 30-day retest period, a significant difference was shown between the machine and the classroom group but no significant difference was shown between the workbook and the classroom group. Significance was restored, however, over the pre-test to 60-day retest period and is shown both between the machine and classroom and between the workbook and classroom groups.

The foregoing data can be related to the major hypotheses of the study and specifically to Hypothesis (1) which states that no significant differences in reading and spelling ability of retarded children will be observed when the same instructional program is presented by means of a teaching machine or programed textbook is not rejected. All of the findings are not consistent in that differences in the reading were observed and differences in spelling ability were not observed.

Hypothesis (2) states that no significant differences in retention will be observed when scores of children taught under automated and programed textbook procedures are compared 30 and 60 days after completion of instruction. This hypothesis also is not rejected. All of the findings are not consistent. While differences were significant for the programed words and for the paragraph reading test, they were not significant for the measures reflecting retention of spelling skills.

Hypothesis (3) states that no significant differences in efficiency and retention of reading and spelling will be observed when retarded children taught by programed instruction are compared to a similar group exposed only to conventional EMH classroom instruction deserves more extended comment. In terms of the scores reflecting gains in programed words and on the paragraph reading test, significant differences were found in favor of the machine-instructed group over the classroom group and in favor of the workbook-instructed group over the classroom group. These differences, which hold over the pre to post-instructional periods and for the 30 and 60-day retest periods, do not refute Hypothesis (3) as it applies to efficiency and retention of reading. That is, no significant differences were found in spelling and reading skills as reflected by scores on the Gray Oral Reading Test.

The lack of significant differences among the groups in terms of pre to post-test scores, pre to 30-day retest scores, and pre to 60-day retest on the programed spelling words, tend to support that portion of Hypothesis (3) which states that "no significant differences in efficiency and retention of spelling will be observed...". Thus, no differences were found in favor of programed instruction over conventional classroom procedures in terms of gain in spelling.

Scores on the Gray Oral Reading Test, which was administered only immediately after instruction, also tend to support that portion of the hypothesis which states that "no significant differences in efficiency and retention of reading will be observed..." The Gray Oral Reading Test, however, did not prove to be a satisfactory measure of reading skills for these retarded. Grade equivalencies commonly used to designate reading achievement of this test are at best questionable. The rather severe time limits imposed by the test held scores for the majority of subjects, both in the programed instruction and classroom groups, below the level at which a grade equivalency could be assigned under the usual normative tables provided by the test authors. The raw score differences used in this study, however, do not reflect significant differences between the groups, or gains for any of them.

Relationships of programed word gain (believed to be the primary measure of difference between the programed instruction and classroom groups) with the factors of mental age, the number of programed words known prior to instruction, scores on the Gray Oral Reading Test, scores on the paragraph reading test and the number of spelling words known prior to instruction were estimated by means of the Pearson product-moment correlation. These correlations are given in Table 4.

TABLE 4

CORRELATIONS BETWEEN PROGRAMED WORD GAIN AND RELATED PRE-TEST VARIABLE (PEARSON r)

PUBLIC SCHOOLS SAMPLE

	MACHINE	WORKBOOK	CLASSROOM
Mental Age	.02	.40	– .28
Programed Words Known (Pre-Test)	.20	.40	.39
Gray Oral Reading	.17	.42	.22
Paragraph Reading	.24	.50	–.02
Spelling Words Known (Pre-Test)	.02	.51	.14

In the previous study, CRP 1267, the number of programed words known prior to instruction was the variable most highly correlated with success in learning new programed words. This relationship was also observed in the present study, although the correlations obtained were not as high as those found for the retarded Ss in CRP 1267. In that group a Pearson r .20 occurred between programed words known prior to instruction and programed word gain for the machine instructed group. For the workbook instructed group the r was .40 and for the control group the r was .39.

Possibly because of the similarities in content and task orientation, a similar relationship prevailed between the programed word gain and pre-instructional scores on the paragraph reading test. An r of .24 occurred between the programed word gain with pre-instruction scores on the paragraph reading test for the machine group, .50 for the workbook group and -.02 for the classroom group.

It is interesting to note that positive rs of .40 and above were obtained between the programed word gain and all of the related variables for those instructed by the workbook method. On the other hand, no correlation, or negative correlations, appeared to exist with the machine group between programed word gain and mental age, and between programed word gain and spelling words known prior to instruction.

THE INSTITUTIONAL GROUP

Table 5 provides a summary of results of the experimental and classroom groups in terms of word gains over the pre-test and post-test period, gains over the pre-test to 30-day retesting, and gains over the pre-test to 60-day retesting. The data in this table represent the major findings of this study for this group.

Among the institutional group subjects, the mean pre-test to post-test word gain for the teaching machine method was 66.4 words and for the workbook group the mean gain was 58.9 words. The gains for these groups are almost 200 percent greater than the mean gain of 21.0 words for the classroom group. These gains also represent nearly 100 percent improvement in terms of gain over words known prior to instruction (see Table 1). The mean gains of both groups of programed instruction subjects were achieved in an average of twenty-three hours of instructional time. Subjects within plus or minus one standard deviation ranged in instructional time from sixteen to twenty-five hours.

Testing done 30 days following completion of instruction revealed mean gain scores of 62.5 words for the machine group and 64.7 words for the workbook group. Because of interference due to institutional work schedules, it was not possible to obtain the 30-day retest for the classroom group.

At the end of 60 days the mean gain score for the machine group was 46.2 words, for the workbook group 51.3 words and, for the classroom group, 21.1 words. As with the public schools sample these scores, representing retention of the words learned, reflected high retention rates of 69.5% for the machine group and 87.1% for the workbook group.

Mean gains in spelling over the pre-instruction to post-instruction period were 1.9 words for the machine group, 1.5 words for the workbook group and 2.4 words for the classroom group. Because of the findings with the public school subjects and because of the lack of spelling progress shown at post-testing, 30 and 60-day retesting was not attempted with the spelling words.

TABLE 5

MEAN WORD GAINS FOLLOWING INSTRUCTIONS

SUNLAND TRAINING CENTER SAMPLE

	Machine	Workbook	Classroom
Programed Words (Words=300)			
Pre-Test to Post-Test	66.4	58.9	21.0
Pre-Test to 30 Day Retest	62.5	64.7	--
Pre-Test to 60 Day Retest	46.2	51.3	21.1
Programed Spelling Words (Words=60)			
Pre-Test to Post-Test	1.9	1.5	2.4
Gray Oral Reading Test (Raw Score)			
Pre-Test to Post-Test	.9	3.1	.9
Paragraph Reading Test (Words=144)			
Pre-Test to Post-Test	38.8	25.2	-11.4
Pre-Test to 30 Day Retest	42.8	32.9	--

Scores on the Gray Oral Reading Test, which reflects relatively few of the words actually being taught via the programed sequences, showed word score gains of only .9 for the machine group, 3.1 for the workbook group and .9 for the classroom group. Therefore, 30 and 60-day retesting was not attempted with the Gray Oral Reading Test.

On the paragraph reading test constructed by the investigators, mean gains over the instructional period were 38.8 words for the machine group and 25.2 words for the workbook group. Over the instructional period the classroom group showed a decrement of 11.4 words. On the 30-day retesting both the machine and the workbook group had gained in scores with means of 42.8 for the machine group and 32.9 for the workbook group. As with the 30-day retesting for programed words, the classroom subjects were not available for retesting at 30 days on the paragraph reading test.

Statistical Analysis of the Scores

Simple analysis of variance was run on all gain scores for all four of the measures utilized. The _F_-ratios are summarized in the Appendix, Table 22. For the Institutional group as a whole, simple analysis of variance showed that the gains in word recognition were significant at the .05 level for the pre-test to post-test period. Further analysis, reported in succeeding paragraphs showed that the differences were occurring, at significant levels, between the machine and classroom groups and between the workbook and classroom groups.

On 30-day retesting, analysis of variance was run only between the machine and workbook groups. Results showed no significant differences between them. This suggests that any gain differences between these groups would be due to chance factors and not due to the method of instruction employed.

Over the period from pre-testing to the 60-day retest, simple analysis of variance showed no significant differences between the machine, workbook and classroom groups. Thus it is clear that the original gains reflected in the pre to post-instructional period could not be maintained by this instructional method.

Because the groups were of unequal size, simple analysis of variance rather than the _t_-test was employed to locate the groups contributing to the significant differences found on programed word gain over the pre-test to post-test period. Results showed no significant differences between the machine and workbook group while differences were significant at the .05 level between the machine and classroom group and between the workbook and classroom group. Only at the close of the instructional period did the same results found with the public schools group prevail.

Analysis of variance was also run on the gains scores representing spelling gain from pre-test to post-test. The F-ratios are summarized in the Appendix, Table 22.

The F-test showed no significant differences between the machine, workbook and the classroom groups on the programed spelling words, consequently t-ratios were not employed. The instructional methods utilized appear to have had no significance on the learning or retention of spelling skills.

Analysis of variance run on raw scores of the paragraph reading test over the pre-test to post-test period revealed differences significant at the .01 level. Because of unequal group sizes, simple analysis of variance was then employed to locate the groups contributing to these differences. No significant difference was found between the teaching machine and workbook groups while differences significant at the .01 level were found between the machine and classroom groups and between the workbook and classroom group. The differences favored the programed instructional groups.

The findings summarized above are worthy of some comment. Hypothesis (1) states that no significant differences in reading and spelling ability of retarded children will be observed when the same instructional program is presented by means of a teaching machine or programed textbook. This hypothesis cannot be rejected since no significant differences occurred in scores between the machine group and the workbook group on the measures of programed word gain, programed spelling word gain, and gain in the paragraph reading test. Significant differences were found between the machine and the workbook groups in terms of raw score gained differences measured by the Gray Oral Reading Test. The findings are substantially the same as those of the public schools group.

Hypothesis (2) states that no significant differences in retention will be observed when children taught under automated and programed textbook procedures are compared 30 to 60 days after completion of instruction. This hypothesis is rejected due to lack of significant differences between gain scores at the 30 and 60 day retesting on the programed words and on the paragraph reading test. It appears that the instructional methods were effective in producing measurable differences in these variables.

Hypothesis (3) states that no significant differences in efficiency and retention of reading and spelling will be observed when retarded children taught by programed instruction are compared to a similar group exposed only to conventional classroom instruction. This hypothesis is also rejected by the majority of the findings for this institutional sample. Significant differences, both in immediate knowledge gained and retention of programed words, were shown between the machine and the classroom subjects and between the workbook and classroom subjects. Significant differences between the machine and classroom group and between the workbook and classroom are also shown on post-instructional testing by means of the paragraph reading test.

While a significant F was shown among the three groups for the programed spelling word gains, it is apparent that these differences favor the classroom group. Since scores on the Gray Oral Reading Test also showed significant differences between the machine and workbook groups only, Hypothesis (3) must be rejected. The findings, however, do not follow the usual pattern of differences shown thus far in this study wherein the differences have favored the programed instructional groups.

As with the public schools sample, relationships between programed word gain, (believed to be the primary measure of difference between the programed instruction and classroom groups) were with the factors of mental age, programed words known, paragraph reading, Gray Oral Reading Test scores and spelling words known on pre-testing, utilizing the Pearson product-moment technique. The results of these correlations are shown in Table 6.

TABLE 6

CORRELATIONS BETWEEN PROGRAMED WORD GAIN AND RELATED PRE-TEST VARIABLE (PEARSON r)

SUNLAND TRAINING CENTER SAMPLE

	MACHINE	WORKBOOK	CLASSROOM
Mental Age	−.12	−.06	.22
Programed Words Known	.10	.57	.53
Gray Oral Reading	.26	.35	.88
Paragraph Reading	−.31	−.58	−.11
Spelling Words Known (Pre-Test)	.44	.76	.71

In the previous study, CRP 1267, the number of programed words known prior to instruction was the factor most highly correlated with success in learning new programed words. This relation held, although not to as great an extent as with the public schools group, and is reflected by the institutional group. A Pearson r of .10 was shown between programed words known prior to instruction and programed word gain for the machine-instructed group. For the workbook-instructed group the r was .57 and for the classroom group the r was .53.

Though non-significant correlations were shown between the programed word gain and mental age, moderate negative correlations were shown between programed word gain and paragraph reading pre-test scores. The negative correlations suggest the possibility of a negative reaction to the reading process on the part of the institutional group subjects. In any event, the institutional subjects differed in this respect from the public schools subjects.

Programed word gain rs varied greatly with the Gray Oral Reading Test. The Pearson r between the Gray Oral Reading Test pre-test scores and word gain was .26 for the machine group, .35 for the workbook group and .88 for the classroom group.

The most significant correlations shown were between programed word gain and the number of spelling words known in pre-testing. Scores here showed .44 between these factors for the machine group, .76 for the workbook group and .71 for the classroom group.

CHAPTER IV

SUMMARY, CONCLUSIONS AND DISCUSSION

Summary

This project represents the second stage of a continuing plan to develop, compare and evaluate programed instruction in reading and spelling skills for retarded children. The first stage, described in CRP 1267 (1963), established that retarded children can acquire and retain these skills more efficiently by means of automated instruction than by the conventional means used in most classrooms for the educable mentally retarded. The current project was built on the experience gained in CRP 1267 but several dimensions were added.

First, the program was expanded so that four times as many words were introduced (N=300, compared to N=72 in CRP 1267). In addition, programing techniques were improved so that more review frames were scheduled throughout the program. Second, it was elected to contrast automated instruction with a programed workbook approach, where the same program was used for the two presentation modes, and both could then be compared to conventional classroom learning. Third, more human intervention in presenting aspects of the program were introduced so that negative reactions to continued exposure to the program itself might be reduced.

The current study had as larger objectives the development of an instructional program of sufficient breadth that retarded children could acquire a basic vocabulary that could lead to minimal functional reading and spelling skills and, in addition, the presentation of the same program in teaching machine and workbook formats so that each could be compared to each other and to conventional classroom instruction. Through use of post instruction testing at 30 day and 60 day intervals, it was also planned to evaluate the retention of skills acquired by means of programed instruction.

Subjects for the study included 96 mentally retarded children from public school EMR classes (N=69) and from classes in a state institution for the retarded (N=30). Public school S̲s ranged in age from 8 to 16 years, with MA's ranging from 5 to 13 years. The institutional S̲s were somewhat older but had lower MA's (CA range 10 to 20 years, with MA's between 5 and 11 years).

Groups were determined in the following manner. First, the records of large numbers of Ss enrolled in EMR classes were studied in terms of criteria suggested by CRP 1267, *i.e.* intelligence, age, sex, reading achievement level, and socio-economic background. Three large and relatively homogeneous groups were defined for both settings (school and institution) and then triads of S̲s representing each group were selected on the basis of similarities on the selection criteria. The groups were then arbitrarily designated as teaching machine group, workbook group, and classroom group. The public schools groups were composed of 23 Ss each. Subjects in the institutional groups comprised only 12 machine group, 11 workbook group and 7 classroom group children, respectively. It is felt that the major contributions of this study relate primarily to EMR children enrolled in public schools, though data for both population samples are presented.

Objective evaluation of instruction was based on the following criteria: the number of programed words known, the number of programed words spelled correctly, raw scores on the Gray Oral Reading Test, and the number of programed words read in context on a paragraph reading test composed by the investigators and including only words used in the program. All Ss were tested on these measures immediately preceding and immediately after completion of instruction, and retests were obtained 30 days and 60 days after the post-test, with some exceptions for the institutional group. Significance of the differences among the criterion variables was identified by means of F-tests and, when significant difference occurred, subsequently by means of t-tests.

The instructional program was presented, as stated, in two modes. The teaching machine group received instruction by means of the Mast Teaching Machine. The workbook group was exposed to the same substantive program presented in workbook form. The classroom Ss were not exposed to the instructional program per se. Classroom teachers were given the list of words included in the program and agreed to present these words, for reading spelling purposes, in the manner each teacher used routinely, and over the same sixteen to twenty weeks required of Ss in the teaching machine group and workbook group to complete the program.

The program itself contained three hundred words with 51% nouns, 26% verbs, 9% adjectives, 6% prepositions, 5% pronouns, and 3% adverbs. Words chosen on the basis of the following criteria: ease of illustration, concreteness, polarities, instructional analysis, word configuration, reinforcements of prior learning, and grammatical aspects. The words selected from the Dolche Word List, the Frye Word List, the Thorndike Word List and Wilson's Essential Vocabulary. The program was administered by research assistants in private rooms provided by the schools and the institution. One to three Ss were supervised at a time.

Results for the public school and institutional samples have been treated separately in the main body of the report. Progress shown by the public school Ss was approximately double that of the institutional sample. The major findings for each of these samples is summarized below.

Public Schools Sample (1) the mean pre to post-instruction word gain for the teaching machine group was 103.7 words; for the workbook group it was 109.0 words. Gains for both groups are thus more than

100% greater than the 46.3 words gained by the classroom group. They also represent more than 100% improvement in words known by the two programed instruction groups prior to beginning instruction. Stated in other terms, most Ss in the machine and workbook groups gained more than 5 words per hour of instruction compared to a mean gain of approximately 2.5 words per hour of instruction per Ss taught by conventional classroom procedures. In no case was attrition in word-recognition at 30 days and 60 days after completing the program greater than 15%.

(2) Gains in spelling over the instructional period were relatively small for all three groups and no significant differences between them were observed. Instructional gains were retained by all three groups on subsequent 30 and 60 day post-testing.

(3) Scores on the Gray Oral Reading Test, which had been chosen initially because it promised to be the most objective measure of reading placement, reflected relatively small gains for each of the three groups. The Gray Oral Reading Test, however, contains many words not used in the program itself. The classroom group showed greater gains on this measure than both programed instruction groups, though differences were not significant. This test was not administered at 30 and 60 day post-instruction intervals.

(4) Pre to post-instruction scores on the paragraph reading test (programed words) revealed mean gains of 29.3 words for the teaching machine group, 28.7 words for the workbook group, and 8.9 words for the classroom group, respectively. These reflect an even greater percentage magnitude of differences in word-recognition between the two programed instruction groups and the classroom group than those given in (1) above. In addition, research assistants reported "reasonable fluency" for most of the Ss in the program instructed groups. At 30 and 60 day post-instruction testing, these two groups retained their high levels of performance. No significant differences occurred between these two groups at any point in testing. On the other hand, although the classroom group gained almost 60% of their post-instruction scores at 60 day retest, there was still a significant difference at that time between mean paragraph reading test scores of the programed instruction groups and that of the classroom group.

Institutional Sample Comparisons of findings for the three groups comprising this sample yielded results essentially the same as those for the public schools sample. The major findings are given in the body of the report. A summary for each of the evaluation measures follows:

(1) For programed word gains alone, the teaching machine group gained an average of 66.4 words, the workbook group gained 58.9 words, and the classroom group gained 21.0 words. These gains reflect greater than 100% improvement over words recognized prior to instruction; they also show that both programed instruction groups gained more than three

times as many words as the classroom group. Finally, the gains remained relatively consistent at 30 day and 60 day post-instruction testing. Thus, although gains in word recognition were not as great for any of the three institutional instruction groups as for the EMR groups in the public schools sample, the patterns of gains and the differences between groups were highly congruent.

(2) Mean gains in spelling for the three groups in this sample were modest at best and reflect no significant progress in this skill. Essentially no differences were observed on immediate post-instruction tests, or on 30 and 60 day post-instruction retests. Apparently, neither the institutional nor public school Ss were able to utilize either programed instruction or routine classroom experience in learning to spell significantly better, in spite of dramatic increases in word recognition.

(3) A comparison of Gray Oral Reading Test pre to post-instruction scores revealed that no significant gains were achieved by any of the three institutional groups on this measure. These findings are consistent with those from the public schools sample. As noted earlier, the Gray Oral Reading Test was not readministered as a retest 30 and 60 days following completion of instruction.

(4) On the paragraph reading test, mean gains over the instructional period were 38.8 words for the teaching machine group, 25.2 words for the workbook group, and 11.4 words for the classroom group. Thus, the proportional differences in gains between the two programed instruction groups and the classroom group were consistent with those for the public schools sample, although actual word gains for each of the three groups were less and assistants did not report that reading fluency obtained for any of the institutional groups.

Conculsions

The hypotheses underlying this study must be considered in terms of the two major population samples.

Hypothesis (1) states that no significant differences in reading and spelling of retarded children will be observed when the same instructional program is presented by means of a teaching machine or a programed workbook. For the Ss enrolled in public school classes, findings were equivocal so that hypothesis cannot be rejected. That is, significant differences in favor of the teaching machine group were observed in terms of number of programed words recognized after instruction (word gains) and in ability to read programed words in context, but no such differences were observed on the Gray Oral Reading Test or in the ability to spell programed words. On the other hand, when these groups from the institutional sample were compared after instruction, no significant differences were observed between them on word gains, the paragraph reading test, or in spelling ability. Post-instruction scores on the Gray Oral Reading Test did however favor the classroom group. Thus the weight of evidence suggests that similar gains in reading and spelling skills can be expected from utilization of this program for retarded children in the age and IQ ranges of those used in this study.

The second major hypothesis states that no significant differences in retention of learned material will be observed when scores of retarded children taught by automated and programed workbook procedures are compared 30 and 60 days after completion of instruction. Again, the findings are not consistent for the two population samples. For the public schools sample, significant differences in favor of teaching machine procedures occurred on word gain and paragraph test criteria but not on retention of spelling skills. For the institutional sample, no significant differences were observed between the teaching machine group and the workbook group for any of the measures used to assess retention of reading and spelling skills. These results are congruent with those observed for hypothesis (1) so far as the two population samples are concerned. Both groups taught by programed instruction retained a large percentage of the word recognition, reading and spelling gains acquired during the instruction. This is one of the major findings of the study. Retention of acquired verbal skills has been a variable investigated in only a very few other studies (e.g. Lawson 1964). Our findings suggest that if retarded children do learn these skills by means of programed instruction they are likely to retain them over a period of at least two months.

Hypothesis (3) states that no significant differences in acquisition and retention of reading and spelling skills will be observed when retarded children taught by programed instruction are compared to a similar group exposed only to conventional EMR classroom instruction. This hypothesis is rejected for both the public school and institutional samples so far as reading skills are concerned. It is not rejected for either sample so far as spelling is concerned. That is, in both the public schools and institutional samples, significant differences were observed, in favor of both teaching machine and programed workbook instruction, for word gains and paragraph reading gains. These differences remained after 30 and 60 day post-instruction evaluations were completed.

Some qualification of the foregoing conclusions should be interjected here. In Chapter II it was pointed out that control over classroom instruction of programed words was not attempted. Teachers did agree to present the words in their usual manner in reading and spelling drills. It was not possible to determine how many times each teacher presented the programed words. Time and other limitations prevented the investigators from studying reading and spelling tests given by the teachers. It can be said confidently, however, that the classroom teachers involved did express complete cooperation within the limits of their responsibility. At the very least, then, it can be concluded that programed instruction, as defined in this project can be extremely helpfull in assisting EMR children to learn to recognize words and to read in context. The data strongly suggest that, as a supplementary teaching tool, it enhances learning far more than exposure only to conventional classroom procedures.

With respect to spelling, however, the same differences did not obtain. For whatever reason, children taught by this program either on the teaching machine or from workbooks did not acquire or retain spelling skills significantly different from those of similar groups exposed only to typical classroom instruction. This was true both for the public schools and institutional samples. Further, there were far less dramatic improvement in any of the groups in spelling skills than in word recognition and paragraph reading skills.

In general, then, it can be concluded that programed instruction, presented to EMR children daily over a period of four to five months at least, can be extremely beneficial in helping them acquire word recognition and contextual reading skills. Perhaps because of the nature of the program used in this study, the same conclusion cannot be made for the acquisition and retention of spelling skills.

Discussion

Experience in building an instructional program of this magnitude and in working daily with approximately one hundred retarded children cannot be reflected adequately in the objective results reported. The investigators feel that it would be useful to point out some of the problems involved in studies like this and to discuss some of the corollary findings.

So far as the program itself is concerned, arbitrary decisions had to be made with respect to the number and choice of words to be used, the visual presentations to accompany exposure of words as frames in the program, the number of frames in each lesson and the corresponding number of lesson units, the manner in which daily lessons were to be introduced by the research assistant, and many such questions. Prior experience with the program used in CRP 1267, and the opportunity to have that program criticized by experts in programed instruction, enabled us to proceed in a reasonably expeditious manner. But decisions about the program were arbitrary, albeit reached through unanimous agreement of the three principal investigators. Copies of the program are available; both for the Mast teaching machine and the workbook presentation modes, and interested persons may obtain them from the investigators or through the U.S. Office of Education.

In comparing the teaching machine with the workbook presentations at a functional level, it is well to point out that the workbook was obviously more economical than the teaching machine for individual use. However, it suffers in comparison in that the workbook is not a controlled presentation device. Children without supervision can cheat by turning pages and looking ahead for correct responses. This cannot be done with the teaching machine. In addition, research assistants reported that children working at the machine seemed to retain their enthusiasm for the programs for a longer time than those using workbooks. This was true in daily sessions and over the extended period of learning. Thus, it is recommended that schools, agencies or institutions desiring to utilize programed instruction purchase at least one teaching machine that can be used consecutively by a number of pupils. Our experience indicates, incidently, that one adult who could be a trained volunteer and not necessarily a certificated teacher, can supervise four to seven and perhaps even ten children at a time. Thus multiple machines increase the number of children who can be taught concurrently. The same can be said, of course, for utilization of programed workbooks. It is important to have an adult in attendance when either type of programed instruction is used.

Subjective reports from classroom teachers indicate that children taught by programed instruction demonstrate increased interest in classroom work generally. This may be an artifact of daily absence from regular classes, although our subjects spent only about twenty minutes per day outside the classroom. It seems reasonable to assume that programed instruction, ancillary to regular class work, does provide incentive for other classroom work. It certainly provides the capability for reducing dreary classroom drill and thus enables the teacher to accomplish other things in the classroom which only a human teacher can provide.

So far as the population samples are concerned a few observations may be useful to the reader. Subjects for this study were selected according to predetermined criteria. Literally hundreds of children were excluded because they either knew too many of the words in this program, or could not be matched on the age, intelligence, socio-economic and other criteria. It is the authors firm belief, based on another study of slow learning, culturally deprived children (USEO Project No. 6-8438, 1967) and also from observing several pre-school normal children work on this program, that most retarded children with an IQ of at least 55 and at least 8 years of age and most children in higher IQ ranges between the ages of 6 to 8 who have word-recognition problems can and could profit from exposure to this program. It is a matter of record that the slow-learning children in Project No. 6-8438 accomplished far more, and more efficiently, than did the EMR children used in the present study. This finding is consistent with the observations for this study, that the children with the highest scores on pre-test word recognition tended to show the most dramatic improvement during instruction.

Also, with respect to the populations of retarded children used here, it should be mentioned that no attempt was made to study children with differing kinds of impairments. It may well be, for example, that some sub-populations of retarded children, e.g. those classified as exogenous; would perform better than those with endogenous impairments. This might be a fruitful field of study regardless of whether the program herein described was used to assess such potential differences.

Finally, it cannot be emphasized too strongly that this is one of a very few studies which report on the retention of acquired verbal skills by retarded children. The investigators feel that this is one of the most important contributions of the present study, confirming as it does their prior findings reported in CRP 1267. The strong suggestion is that, although retarded children as a group do not learn as efficiently as children in higher IQ ranges, what they do learn is retained to a large degree. Since programed instruction of the sort used in this study contributed to increased learning (at least in basic reading skills) than did exposure only to conventional classroom instruction, and since a large percentage of learned skills were retained, the implication is that this new educational technology deserves wider consideration by teachers of retarded children than it is currently receiving.

APPENDIX

TABLE 7

SIMPLE ANALYSIS OF VARIANCE

MATCHING VARIABLES

PUBLIC SCHOOLS SAMPLE

SOURCE	df	SS	MS	F
MENTAL AGE				
Between Gps.	2	.51	.26	.08
Within Gps.	66	221.47	3.36	
Total	68	221.98		
PROGRAMED WORDS				
Between Gps.	2	316.25	158.24	.08
Within Gps.	66	128,321.48	1,944.26	
Total	68	128,637.73		
GRAY ORAL READING (RAW SCORES)				
Between Gps.	2	42.13	21.06	1.05
Within Gps.	66	1,325.86	20.09	
Total	68	1,367.99		
PARAGRAPH READING				
Between Gps.	2	520.26	260.13	.42
Within Gps.	66	40,114.41	612.75	
Total	68	40,634.67		

TABLE 8

SIMPLE ANALYSIS OF VARIANCE

MATCHING VARIABLES

SUNLAND TRAINING CENTER

SOURCE	df	SS	MS	F
MENTAL AGE				
Between Gps.	2	1.42	.71	.29
Within Gps.	27	65.40	2.42	
Total	29	66.82		
PROGRAMED WORDS				
Between Gps.	2	1,027.90	513.95	.40
Within Gps.	27	35,122.39	1,300.83	
Total	29	36,150.29		
GRAY ORAL READING (RAW SCORES)				
Between Gps.	2	.48	.24	.02
Within Gps.	27	281.00	10.41	
Total	29	281.48		
PARAGRAPH READING				
Between Gps.	2	1,311.69	655.84	2.55
Within Gps.	27	6,950.81	257.44	
Total	29	8,262.50		

TABLE 9

PROGRAMED WORDS
(N=300)

book
come
*for
*two
eat
do
tree
we
*off
*man
father
out
this
play
*big
be
fire
*baby
run
on

water
boat
I
sun
that
love
ride
*help
his
name
us
call
cut
girl
house
hot
day
light
window
some

are
have
take
*buy
read
fast
under
was
woman
*policeman
walk
put
watch
open
*truck
bed
hospital
make
chair
with

*write
money
*has
they
*work
bathroom
sleep
*slow
grass
*who
*will
from
use
bread
*store
now
bell
elephant
bridge
street

pencil
brother
*gas
*head
pay
*him
listen
pull
glass
bank
want
*closed
hurt
dangerous
*something
teacher
summer
left
ring
stop

* Spelling words

TABLE 9 (CONTINUED)

PROGRAMED WORDS

no
milk
*down
dog
*ball
up
*eggs
and
*can
*you
cup
Mr.
*little
school
*boy
in
*mother
fish
apple
*black

white
old
the
is
my
toy
cow
bag
can't
not
get
*door
cold
bus
cake
poison
fall
key
am
today

your
time
did
over
five
clothes
way
ask
*television
she
yes
of
coat
hand
birthday
children
train
candy
radio
table

here
*soap
gives
*shoes
food
*her
*saw
when
right
side
exit
keep
ate
telephone
mailbox
dress
sit
what
letter
*drink

say
child
coffee
dollar
mine
sister
might
gave
bath
*need
meat
paper
*dig
wet
clock
tell
church
grocery
one
box

*Spelling words

TABLE 9 (CONTINUED)

PROGRAMED WORDS

go
jump
a
*car
cat
look
*hat
Mrs.
all
shirt
pants
newspaper
*nurse
dime
*turtle
gate
frog
way
talk
*ground

break
*came
doctor
it
*present
*said
new
stand
hear
*corn
*potatoes
*station
eye
hole
flag
town
dry
live
cents
ten

dentist
first
smoke
smoking
dinner
*these
safe
cook
front
danger
behind
job
adult
taxi
soldier
star
towel
*rain
*floor
elevator

stairs
numbers
belt
*teeth
ear
swim
like
line
movie
map
leg
sandwich
iron
shows
gone
*cash
*loud
cashier
address
*winter

quiet
went
aid
push
learn
entrance
bring
*private
beware
railroad crossing
again
think
morning
both
*please
until
around
yellow
he
see

*Spelling words

TABLE 10

PARAGRAPH READING TEST

1. That house has a window in it.
2. The black and white cow can eat grass.
3. She plays with the boat in the water.
4. Children love to eat candy and cake.
5. Today is my birthday. Is it your birthday?
6. A doctor and a nurse work in a hospital.
7. He drinks hot coffee and cold milk.
8. I take a bus to go to town.
9. They want to put money in the bank.
10. Is the radio under the table?
11. That big policeman was a little baby.

1. I can hear my telephone ring.
2. Teachers show us something to learn.
3. The dentist did buy a newspaper.
4. A doctor can help children when they are hurt.
5. I use bread to make a sandwich.
6. I gave my sister some coffee to drink.
7. A bridge is dangerous when it is all wet.
8. I pay the cashier money to go in the movies.

[1] All of the above are programed words.

TABLE 11

PROGRAMED WORDS

GAINS AND RETENTION OF INDIVIDUAL SUBJECTS

PUBLIC SCHOOLS SAMPLE

	MACHINE			WORKBOOK			CLASSROOM		
SUBJECTS	Word Gains Pre to Post	Retained at 30 Days	Retained at 60 Days	Word Gains Pre to Post	Retained at 30 Days	Retained at 60 Days	Word Gains Pre to Post	Retained at 30 Days	Retained at 60 Days
1	95	78	147	72	67	55	25	28	23
2	74	64	63	113	108	105	39	41	49
3	144	122	122	124	120	101	30	46	35
4	90	77	101	102	97	103	80	93	108
5	155	127	159	90	82	77	150	69	95
6	105	89	82	157	150	126	*	*	*
7	125	127	119	106	102	115	84	88	81
8	144	127	136	109	96	114	18	18	18
9	92	86	102	107	112	121	69	70	61
10	151	149	132	58	61	67	35	24	28
11	61	48	60	128	119	119	24	28	20
12	94	86	78	25	34	26	14	15	11
13	147	82	90	111	103	110	36	25	20
14	87	62	59	112	87	54	46	29	53
15	113	104	*	124	111	104	66	57	79
16	107	106	122	72	*	57	9	21	11
17	29	30	27	79	87	70	26	23	26
18	104	101	117	*	*	*	40	52	45
19	59	53	58	112	74	68	13	27	32
20	104	86	126	76	88	86	57	62	62
21	104	92	105	103	105	119	81	86	97
22	96	86	89	118	116	115	36	45	58
23	106	40	114	122	123	128	40	46	60

*Subjects not available for testing.

TABLE 12

STANDARD DEVIATIONS OF MEAN SCORE GAINS

PUBLIC SCHOOLS SAMPLE

	Machine	Workbook	Classroom
Programed Words (Words = 300)			
Pre-Test to Post Test	30.69	27.64	31.61
Pre-Test to 30 Day Retest	29.65	24.62	19.48
Pre-Test to 60 Day Retest	32.54	28.16	28.63
Programed Spelling Words (Words=60)			
Pre-Test to Post Test	1.69	1.49	1.40
Pre-Test to 30 Day Retest	5.09	5.58	5.84
Pre-Test to 60 Day Retest	5.53	4.94	5.57
Gray Oral Reading Test (Raw Score)			
Pre-Test to Post-Test	2.58	2.38	2.29
Paragraph Reading Test (Words=144)			
Pre-Test to Post-Test	14.65	14.48	13.83
Pre-Test to 30 Day Retest	14.61	15.88	14.96
Pre-Test to 60 Day Retest	14.71	13.64	17.22

TABLE 13

SPELLING WORDS

GAINS AND RETENTION OF INDIVIDUAL SUBJECTS

PUBLIC SCHOOLS SAMPLE

SUBJECTS	MACHINE			WORKBOOK			CLASSROOM		
	Word Gains Pre to Post	Retained at 30 Days	Retained at 60 Days	Word Gains Pre to Post	Retained at 30 Days	Retained at 60 Days	Word Gains Pre to Post	Retained at 30 Days	Retained at 60 Days
1	-4	1	3	0	0	3	1	-2	1
2	5	6	3	4	-1	1	0	-5	-4
3	4	3	0	8	0	0	3	-3	1
4	14	15	17	5	3	6	1	7	8
5	19	14	19	9	1	2	8	9	9
6	2	1	0	6	3	5	*	*	*
7	-1	5	7	5	9	8	5	5	4
8	11	11	15	0	0	4	-1	0	3
9	2	6	3	2	12	12	7	14	12
10	9	5	6	11	12	8	8	9	7
11	3	3	1	1	7	8	-9	-4	-5
12	12	7	8	1	0	0	1	4	7
13	4	14	9	17	14	16	8	0	2
14	1	-3	2	8	6	4	1	1	6
15	11	7	*	5	11	13	11	4	7
16	6	9	3	-1	*	2	-2	7	6
17	2	0	-2	4	6	2	0	3	2
18	1	13	2	*	*	*	7	8	12
19	7	-1	7	4	-2	4	4	2	1
20	0	0	0	1	-1	-1	8	15	16
21	8	8	3	11	12	11	3	9	6
22	5	10	7	13	12	16	6	16	18
23	11	3	10	9	14	6	5	8	9

* Subjects not available for testing.

TABLE 14

GRAY ORAL READING

PRE, POST AND GAINS (RAW SCORES) OF INDIVIDUAL SUBJECT

PUBLIC SCHOOLS SAMPLE

	MACHINE			WORKBOOK			CLASSROOM		
Subjects	Pre	Post	Gain	Pre	Post	Gain	Pre	Post	Gain
1	2	2	0	4	2	-2	2	4	2
2	7	0	-7	7	7	0	14	13	-1
3	10	13	3	5	9	4	7	12	5
4	9	10	1	11	15	4	22	23	1
5	5	5	0	0	3	3	9	9	0
6	6	6	0	10	7	-3	8	*	*
7	8	6	-2	4	6	2	11	10	-1
8	8	7	-1	2	3	1	5	7	2
9	4	8	4	11	15	4	14	19	5
10	6	9	3	6	6	0	5	10	5
11	0	0	0	3	3	0	9	7	-2
12	3	6	3	0	0	0	0	0	0
13	8	7	-1	9	14	5	2	5	3
14	7	8	1	4	4	0	3	7	4
15	10	12	2	8	8	0	12	16	4
16	14	16	2	9	9	0	3	3	0
17	4	3	-1	1	5	4	1	7	6
18	11	11	0	4	*	*	11	14	3
19	3	6	3	0	2	2	1	2	1
20	3	8	5	2	2	0	5	7	2
21	9	9	0	11	15	4	9	15	6
22	12	17	5	9	5	-4	13	15	2
23	8	7	-1	15	16	1	13	15	2

* Subjects not available for testing.

TABLE 15

PARAGRAPH READING

GAINS AND RETENTION OF INDIVIDUAL SUBJECTS

PUBLIC SCHOOLS SAMPLE

	MACHINE			WORKBOOK			CLASSROOM		
SUBJECTS	Word Gains Pre to Post	Retained at 30 Days	Retained at 60 Days	Word Gains Pre to Post	Retained at 30 Days	Retained at 60 Days	Word Gains Pre to Post	Retained at 30 Days	Retained at 60 Days
1	12	21	51	27	13	20	13	15	21
2	23	22	25	17	15	19	13	-2	12
3	37	-2	36	15	18	17	22	23	26
4	20	19	26	23	22	24	10	11	9
5	69	68	75	59	50	42	19	15	26
6	12	21	14	42	46	46	*	*	*
7	42	38	39	28	26	33	15	26	29
8	53	50	51	35	17	39	1	-5	0
9	17	13	18	21	0	22	16	11	20
10	46	42	40	14	25	22	32	39	42
11	27	25	40	60	53	42	-37	-42	-42
12	33	28	35	9	-3	-5	1	20	-5
13	29	23	25	47	44	48	11	10	13
14	16	6	12	33	21	1	0	17	17
15	28	28	*	26	24	25	11	12	18
16	18	17	22	12	*	16	2	4	-2
17	19	21	33	17	-7	19	3	36	41
18	17	19	18	*	*	*	4	0	2
19	24	19	22	42	32	38	5	10	6
20	50	41	44	45	36	41	31	27	23
21	18	15	18	21	23	24	10	14	14
22	24	22	22	23	25	25	-6	3	5
23	40	37	42	16	13	13	20	17	21

* Subjects not available for testing.

TABLE 16

PROGRAMED WORDS

GAINS AND RETENTION OF INDIVIDUAL SUBJECTS

SUNLAND TRAINING CENTER SAMPLE

	MACHINE			WORKBOOK			CLASSROOM		
SUBJECTS	Word Gains Pre to Post	Retained at 30 Days	Retained at 60 Days	Word Gains Pre to Post	Retained at 30 Days	Retained at 60 Days	Word Gains Pre to Post	Retained at 30 Days	Retained at 60 Days
1	46	47	32	148	151	123	35	*	33
2	40	46	48	30	33	25	4	*	6
3	65	61	52	110	114	107	29	*	42
4	42	39	39	51	68	63	13	*	9
5	41	41	17	88	*	64	7	*	8
6	49	39	36	12	28	9	17	*	12
7	71	73	53	20	*	17	42	*	38
8	121	65	72	77	98	78			
9	56	63	42	30	34	34			
10	121	97	79	24	28	21			
11	111	124	*	58	28	23			
12	34	55	38						

*Subjects not available for testing at 30 day due to institutional work project.

TABLE 17

STANDARD DEVIATIONS OF MEAN SCORE GAINS

SUNLAND TRAINING CENTER SAMPLE

	Machine	Workbook	Classroom
Programed Words (Words=300)			
Pre-Test to Post-Test	31.34	40.89	13.45
Pre-Test to 30 Day Retest	24.54	43.44	---
Pre-Test to 60 Day Retest	16.84	36.84	14.60
Programed Spelling Words (Words=60)			
Pre-Test to Post Test	2.47	5.00	6.50
Gray Oral Reading Test (Raw Score)			
Pre-Test to Post Test	3.45	4.68	2.56
Paragraph Reading Test (Words=144)			
Pre-Test to Post Test	20.15	15.19	17.47
Pre-Test to 30 Day Retest	18.00	18.16	---

TABLE 18

SPELLING WORDS

PRE, POST AND GAINS OF INDIVIDUAL SUBJECTS

SUNLAND TRAINING CENTER SAMPLE

	MACHINE			WORKBOOK			CLASSROOM		
Subjects	Pre	Post	Gain	Pre	Post	Gain	Pre	Post	Gain
1	3	7	4	28	19	-9	20	22	2
2	2	0	-2	4	9	5	0	0	0
3	10	10	0	17	20	3	0	18	18
4	2	2	0	0	0	0	0	0	0
5	0	3	3	6	0	-6	0	0	0
6	1	0	-1	4	13	9	0	0	0
7	2	4	2	7	8	1	20	17	-3
8	0	1	1	5	9	4			
9	4	9	5	6	12	6			
10	8	10	2	7	11	4			
11	12	19	7	0	0	0			
12	4	6	2						

TABLE 19

GRAY ORAL READING

PRE, POST AND GAINS (RAW SCORES) OF INDIVIDUAL SUBJECTS

SUNLAND TRAINING CENTER SAMPLE

	MACHINE			WORKBOOK			CLASSROOM		
Subjects	Pre	Post	Gain	Pre	Post	Gain	Pre	Post	Gain
1	2	1	-1	8	12	4	9	13	4
2	5	5	0	0	6	6	0	2	2
3	5	3	-2	2	12	10	11	15	4
4	11	2	-9	5	10	5	0	0	0
5	0	0	0	5	5	0	0	0	0
6	4	3	-1	7	7	0	1	0	-1
7	6	8	2	2	2	0	7	4	-3
8	8	7	-1	5	10	5			
9	0	7	7	3	9	6			
10	4	2	-2	3	1	-2			
11	6	4	-2	7	7	0			
12	9	7	-2						

TABLE 20

PARAGRAPH READING

PRE-POST AND RETAINED SCORES BY INDIVIDUAL SUBJECTS

SUNLAND TRAINING CENTER SAMPLE

	MACHINE			WORKBOOK			CLASSROOM		
SUBJECTS	Pre-Test	Post-Test	Retained at 30 Days	Pre-Test	Post-Test	Retained at 30 Days	Pre-Test	Post-Test	Retained at 30 Days
1	85	89	96	60	71	*	85	97	*
2	73	132	131	70	131	135	63	29	*
3	66	113	126	65	82	78	115	117	*
4	76	99	94	70	79	86	74	42	*
5	69	85	89	53	67	91	112	119	*
6	73	88	113	76	103	103	55	32	*
7	54	85	81	75	90	94	53	41	*
8	56	96	107	89	136	135			
9	58	103	110	88	110	124			
10	50	114	112	96	122	132			
11	53	106	100	76	104	*			
12	58	127	127						

* Subjects not available for testing at 30 day due to institutional work project.

TABLE 21

SIMPLE ANALYSIS OF VARIANCE

PUBLIC SCHOOLS SAMPLE

PROGRAMED WORD GAINS

SOURCE	df	SS	MS	F
Pre-Test to Post Test				
Between Gps.	2	46,570.91	23,285.46	24.65*
Within Gps.	64	60,448.45	944.51	
Total	66	107,019.36		
Pre-Test to 30 Day Retest				
Between Gps.	2	34,235.73	7,117.86	10.91*
Within Gps.	63	41,115.83	652.63	
Total	65	75,351.56		
Pre-Test to 60 Day Retest				
Between Gps.	2	50,157.80	25,078.90	26.87*
Within Gps.	63	58,791.02	933.19	
Total	65	108,948.82		

SPELLING WORD GAINS

SOURCE	df	SS	MS	F
Pre-Test to Post-Test				
Between Gps.	2	72.44	36.22	1.49
Within Gps.	64	1,556.79	24.33	
Total	66	1,629.23		
Pre-Test to 30 Day Retest				
Between Gps.	2	17.80	8.90	.28
Within Gps.	63	1,998.22	31.72	
Total	65	2,016.02		
Pre-Test to 60 Day Retest				
Between Gps.	2	3.96	1.98	.07
Within Gps.	63	1,891.90	30.03	
Total	65	1,895.86		

* F of 4.98 significant at .01 level

TABLE 21 (CONTINUED)

SIMPLE ANALYSIS OF VARIANCE

PUBLIC SCHOOLS SAMPLE

GRAY ORAL READING (RAW SCORES)

SOURCE	df	SS	MS	F
Pre-Test to Post-Test				
Between Gps.	2	24.27	12.14	1.97
Within Gps.	64	393.42	6.15	
Total	66	417.69		

PARAGRAPH READING

SOURCE	df	SS	MS	F
Pre-Test to Post Test				
Between Gps.	2	5,972.65	2,986.33	13.90*
Within Gps.	64	13,753.13	214.89	
Total	66	19,725.78		
Pre-Test to 30 Day Retest				
Between Gps.	2	3,287.90	1,643.95	6.95*
Within Gps.	63	14,901.64	236.53	
Total	65	18,189.54		
Pre-Test to 60 Day Retest				
Between Gps.	2	4,002.90	2,001.45	8.19*
Within Gps.	63	15,397.10	244.40	
Total	65	19,400.00		

* F of 4.98 significant at .01 level

TABLE 22

SIMPLE ANALYSIS OF VARIANCE

SUNLAND TRAINING CENTER SAMPLE

PROGRAMED WORD GAINS

SOURCE	df	SS	MS	F
Pre-Test to Post-Test				
Between Gps.	2	9,707.83	4,853.92	4.17**
Within Gps.	27	31,438.27	1,164.28	
Total	29	41,146.10		
Pre-Test to 30 Day Retest (Machine to Workbook only)				
Between Gps.	1	22.23	22.23	.017
Within Gps.	19	24,209.11	1,274.16	
Total	20	24,231.34		
Pre-Test to 60 Day Retest				
Between Gps.	2	4,174.98	2,087.49	2.78
Within Gps.	26	19,548.50	751.87	
Total	28	23,723.48		

** F of 3.35 significant at .05 level

SPELLING WORD GAINS

SOURCE	df	SS	MS	F
Pre-Test to Post-Test				
Between Gps.	2	2.39	1.20	.05
Within Gps.	27	644.31	23.86	
Total	29	646.70		

TABLE 22 (CONTINUED)

SIMPLE ANALYSIS OF VARIANCE

SUNLAND TRAINING CENTER SAMPLE

GRAY ORAL READING (RAW SCORE)

SOURCE	df	SS	MS	F
Pre-Test to Post-Test				
Between Gps.	2	92.23	46.12	3.89**
Within Gps.	27	320.57	11.87	
Total	29	412.80		

** F of 3.35 significant at .05 level

PARAGRAPH READING

SOURCE	df	SS	MS	F
Pre-Test to Post-Test				
Between Gps.	2	11,315.75	5,657.88	15.97*
Within Gps.	27	9,564.95	354.26	
Total	29	20,880.70		
Pre-Test to 30 Day Retest (Machine and Workbook only)				
Between Gps.	1	427.92	427.92	1.35
Within Gps.	19	6,044.25	318.12	
Total	20	6,472.17		

* F of 5.49 significant at .01 level

TABLE 23

t RATIOS BETWEEN TREATMENT GROUP MEANS

PUBLIC SCHOOLS SAMPLE

PROGRAMED WORDS

	WORKBOOK	CLASSROOM
Pre-Test to Post-Test		
Machine	.31	6.96*
Workbook		6.57*
Pre-Test to 30 Day Retest		
Machine	1.27	6.18*
Workbook		8.43*
Pre-Test to 60 Day Retest		
Machine	.75	6.37*
Workbook		6.13*

PARAGRAPH READING

	WORKBOOK	CLASSROOM
Pre-Test to Post-Test		
Machine	.28	6.09*
Workbook		3.69*
Pre-Test to 30 Day Retest		
Machine	.75	3.34*
Workbook		1.83
Pre-Test to 60 Day Retest		
Machine	1.72	4.24*
Workbook		6.59*

* Significant at or above .01 significance level.

TABLE 24

SIMPLE ANALYSIS OF VARIANCE

SUNLAND TRAINING CENTER SAMPLE

PROGRAMED WORDS
(Pre to Post Test)

SOURCE	ds	SS	MS	F
MACHINE - WORKBOOK				
Between Gps.	1	318.70	318.70	.22
Within Gps.	21	30,171.27	1,436.73	
Total	22	30,489.97		
MACHINE - CLASSROOM				
Between Gps.	1	9,132.54	9,132.54	11.90*[1]
Within Gps.	17	13,050.56	767.68	
Total	18	22,183.10		
WORKBOOK - CLASSROOM				
Between Gps.	1	6,143.47	6,143.47	5.00*[2]
Within Gps.	16	19,654.71	1,228.42	
Total	17	25,798.18		

*[1] F of 8.40 significant at .01 level

*[2] F of 8.53 significant at .01 level

GRAY ORAL READING TEST
(Pre to Post Test)

SOURCE	df	SS	MS	F
MACHINE - WORKBOOK				
Between Gps.	1	92.25	92.25	6.93*
Within Gps.	21	279.75	13.32	
Total	22	372.00		
MACHINE - CLASSROOM				
Between Gps.	1	2.46	2.46	.23
Within Gps.	17	183.62	10.80	
Total	18	186.08		
WORKBOOK - CLASSROOM				
Between Gps.	1	21.49	21.49	1.93
Within Gps.	16	177.77	11.11	
Total	17	199.26		

* F of 8.02 significant at .01 level

TABLE 24 (CONTINUED)

SIMPLE ANALYSIS OF VARIANCE

SUNLAND TRAINING CENTER SAMPLE

	PARAGRAPH READING (Pre to Post Test)			
SOURCE	df	SS	MS	F
MACHINE - WORKBOOK				
Between Gps.	1	1,079.90	1,079.90	3.05
Within Gps.	21	7,427.43	353.69	
Total	22	8,507.33		
MACHINE - CLASSROOM				
Between Gps.	1	11,136.62	11,136.62	26.97*[1]
Within Gps.	17	7,020.28	412.96	
Total	18	18,156.90		
WORKBOOK - CLASSROOM				
Between Gps.	1	5,744.57	5,744.57	19.63*[2]
Within Gps.	16	4,682.19	292.64	
Total	17	10,426.76		

*[1] *F* of 8.40 significant at .01 level

*[2] *F* of 8.53 significant at .01 level

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